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Hall Thruster for Small, Low Power Satellites

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MEMORANDUM FOR PRS (In-House Publication)

FROM: PROI (STINFO)

17 Dec 2002

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-SB-2002-315**
W. Hargus (PRSS); D. Spotts, "SBIR Success Story: Busek 200 W Hall Thruster"

SBIR Topic AF95-096
(Deadline: ?? Dec 2002)

(Statement A)

SBIR Topic: AF95-096

Contract Number: F04611-96-C-0023

Title: "Hall Thruster for Small, Low Power Satellites"

Air Force Requirements:

The Air Force has the stated goal of gaining and retaining space dominance to protect US interests in all parts of the world. This will require large numbers of new satellites with uninterrupted, all weather coverage of the Earth's surface. To provide these capabilities at reasonable cost, new propulsion technologies, which utilize fuel more efficiently, are being developed. These propulsion technologies use electrical energy to accelerate plumes of ions and electrons to more efficiently propel satellites thus lowering the cost to maintain and launch these spacecraft vital to our national interests.

SBIR Technology:

Busek Company, Inc. was awarded Small Business Innovation Research (SBIR) contracts to construct and validate a 200 W Hall effect thruster (HET) propulsion system for the Air Force Propulsion Directorate (AFRL/PR). The 200 W HET system developed by Busek consists of three parts: the anode discharge where electrons are confined with magnetic fields and xenon ions are created and subsequently accelerated; the hollow cathode neutralizer which provides electrons to neutralize the ion beam produced by the anode; and the propellant and power management system which regulate electrical power and propellant flow to the anode and cathode. The system has an electrical efficiency of approximately 35% (thrust power output divided by total electrical power input) at its nominal operating power of 200 W. Typically Hall thrusters operate at higher powers (≥ 2 kW). Prior to this work, it was deemed impossible to scale down to such low power levels while maintaining a useful efficiency level. This challenge required Busek to innovate and design a new magnetic field configuration as well as a new propellant distribution system within the anode body. These two innovations to the field of electric propulsion resulted in the first demonstration of an efficient low power Hall thruster.

Dr. William A. Hargus, Jr.
AFRL/PRSS - DSN 525-6799

This effort was not only technically successful, it also resulted in a successful patent application for Busek.

Air Force Payoff / Technology Transfer:

This low power HET propulsion system developed by Busek recently competed to supply primary propulsion for the TechSat-21 constellation. The TechSat-21 program consists of three satellites, which will be used by the Space Vehicles Directorate (AFRL/VS) to demonstrate satellite formation operations and dispersed aperture sensor arrays. Although not initially expected to win the contract, Busek beat a number of competitors by showcasing short pulse Hall thruster operation not previously thought possible. TRW has teamed with Busek to place 200 W HET systems on each spacecraft to provide primary propulsion as well as the fine tune pulses to precisely align the spacecraft payloads. Due to this success, Busek is in talks with NASA and several prime contractors to place their low power HET systems on several other space vehicles.

Air Force Program Managers:

The Phase I and Phase II SBIR programs were managed by Dr. Ronald Spores of the Propulsion Directorate Spacecraft Propulsion Branch (AFRL/PRSS). Daron Bromaghim of the Spacecraft Propulsion Branch is managing the TechSat-21 propulsion system development. The Critical Design Review (CDR) of TechSat-21 has been completed and launch is scheduled for late 2005.

SBIR Partner:

Busek Company, Inc.
Natick, Mass.

Employees:

Figure 1: Busek 200 W Hall Thruster (BHT-200)

Figure 2: Graphic of the TechSat-21 Constellation

